plane and is disposed on a support surface that has openings adjacent a first side of the plane. The method includes providing a combined replication and vacuum injection tool on a second side of the plane. A respective optical element is formed on each of the transparent substrates on the second side of the plane by a replication technique using the combined replication and vacuum injection tool. The openings in the support surface are filled with a first non-transparent material, and spacer elements composed of the non-transparent material are formed on the second side of the plane by a vacuum injection process using the combined replication and vacuum injection tool.

According to another aspect, an optoelectronic module includes an optoelectronic device mounted on a substrate, a transparent cover separated from the substrate by a spacer, and an optical element attached to the transparent cover. Sidewalls of the transparent cover are covered by a first material that is non-transparent to light emitted by or detectable by the optoelectronic device, and the first non-transparent material is surrounded laterally by a second different non-transparent material. In some implementations, the first non-transparent material is a polymer material (e.g., epoxy, acrylate, polyurethane, or silicone) containing a non-transparent filler (e.g., carbon black, pigment, or dye), and the second non-transparent material is a glass-reinforced epoxy laminate material. Other non-transparent materials can be used as well.

In accordance with yet another aspect, a method of fabricating optoelectronic modules includes providing a substrate wafer that comprises a metal frame and a molded cavity, wherein portions of the metal frame are encapsulated laterally by the molded cavity, and the metal frame has optoelectronic devices mounted thereon and separated laterally from one another. The method includes providing a spacer/optics structure that includes singulated transparent substrates separated laterally from one another, the spacer/optics structure including a spacer element that projects away from the transparent substrates, wherein sidewalls of each of the transparent substrates is encapsulated laterally by a non-transparent material. An end of the spacer element is attached to the molded cavity to form a stack.

In some instances, a module may include an optics assembly on the object-side of the transparent cover. The optics assembly can include, for example, one or more lenses (e.g., a vertical stack of injection molded lenses).

Other aspects, features and advantages will be readily apparent from the following detailed description, the accompanying drawings and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows an example of an optoelectronic module.

FIGS. **2**A-**2**H show examples of optoelectronic modules.

FIGS. **3**A-**3**E illustrate steps in a method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **4**A-**4**C illustrate steps in a method of fabricating optoelectronic modules having tilted transparent substrates.

FIGS. **5**A-**5**E illustrate steps in another method of fabricating optoelectronic modules having tilted transparent substrates.

FIGS. **6**A-**6**C illustrate steps in a yet a further method of fabricating optoelectronic modules having tilted transparent substrates.

FIGS. **7**A-**7**E illustrate steps in another method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **8**A-**8**D illustrate steps in yet a further method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **9**A-**9**D illustrate steps in another method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **10**A-**10**B illustrate steps in a further method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **11**A-**11**B illustrate steps in yet a further method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **12**A-**12**D illustrate steps in yet a further method of fabricating optoelectronic modules using singulated transparent substrates.

FIGS. **13**A-**13**E illustrate steps for fabrication of proximity sensor modules that include both a light emitting element and a light detecting element in adjacent channels.

FIGS. **14**A-**14**D illustrate steps in a method of fabricating optoelectronic modules using a wafer with transparent portions surrounded by non-transparent material.

FIGS. **15**A-**15**F illustrate steps in accordance with another method of fabricating optoelectronic modules using transmissive substrates that span across multiple optoelectronic devices.

FIG. **16** is an example of a module obtained by the process of FIGS. **15**A-**15**F.

FIGS. **17**A-**17**F illustrate steps in accordance with yet another method of fabricating optoelectronic modules using transmissive substrates that span across multiple optoelectronic devices.

FIGS. **18**A-**18**B illustrate additional steps for fabricating optoelectronic modules according to some implementations.

FIG. **19** illustrates a first example of separating the structure of FIG. **18**B.

FIG. **20** is an example of a module obtained by the separating of FIG. **19**.

FIG. **21** illustrates a first example of separating the structure of FIG. **18**B.

FIG. **22** is an example of a module obtained by the separating of FIG. **21**.

FIGS. **23**A-**23**C are further examples of modules.

FIGS. **24**A and **24**B illustrate steps in a method of fabricating optoelectronic modules.

FIGS. **25**A-**25**G are further examples of modules.

DETAILED DESCRIPTION

The present disclosure describes various techniques for fabricating optoelectronic modules that include non-transparent material on the exterior sidewalls of the transparent cover. An example of such a module is illustrated in FIG. **2**A, which shows a module **20** including an optoelectronic device **22** mounted on a printed circuit board (PCB) or other substrate **24**. Examples of the optoelectronic device **22** include a light emitting element (e.g a LED, an IR LED, an OLED, an IR laser or a VCSEL) or a light detecting element (e.g., a photodiode or other light sensor).

A transparent cover **26** composed, for example, of glass, sapphire or a polymer material, is separated from substrate **24** by a spacer **28**. Spacer **28** surrounds optoelectronic device **22** and serves as sidewalls for the module. Transparent cover **26** generally is transparent to wavelengths of light emitted by or detectable by optoelectronic device **22**. Spacer **28** preferably is composed of a non-transparent material, such as a vacuum injected polymer material (e.g., epoxy, acrylate, polyurethane, or silicone) containing a non-trans-